

# REHABILITATION OF NONSTRUCTURAL ARCHITECTURAL COMPONENTS

## 5.0 INTRODUCTION

Nonstructural architectural elements can be damaged in an earthquake, and some of this damage may result in life-threatening hazards. The two principal causes of architectural damage are differential motion and lack of component capacity. For example, the differential seismic displacement between stories (i.e., drift) can cause window breakage. Architectural cladding, such as a granite veneer, with insufficient anchorage capacity is an example of a component with a lack of capacity.

## 5.1 EXTERIOR CURTAIN WALLS

Rigid nonductile curtain wall panels, (e.g., those constructed of precast concrete) attached to the exterior of a flexible structure (e.g., a steel moment frame) may have insufficient flexibility in their connections to the frame and insufficient spacing between panels to prevent damage due to racking. The connection details therefore may have to be modified to allow flexibility, and Figure 5.1a shows a typical connection detail that provides ductility and rotational capacity. The panel is rigidly attached at the base and held with a flexible rod at the top. It usually is desirable to provide a rigid support at one end of each panel and to allow the other end to translate to accommodate the interstory deflection of the frame without racking of the panels.

Another common deficiency is that the existing connections may not provide adequate freedom for accommodating the calculated horizontal and vertical story distortions. A feasible remedy may be to remove the existing connections at one end of the panels and replace them with flexible rods (as indicated in Figure 5.1b) or with other connecting devices provided with adequate oversized and slotted holes. In implementing these techniques, the capacity of the modified connection for gravity loads and for out-of-plane seismic loads must be checked and strengthened if necessary.

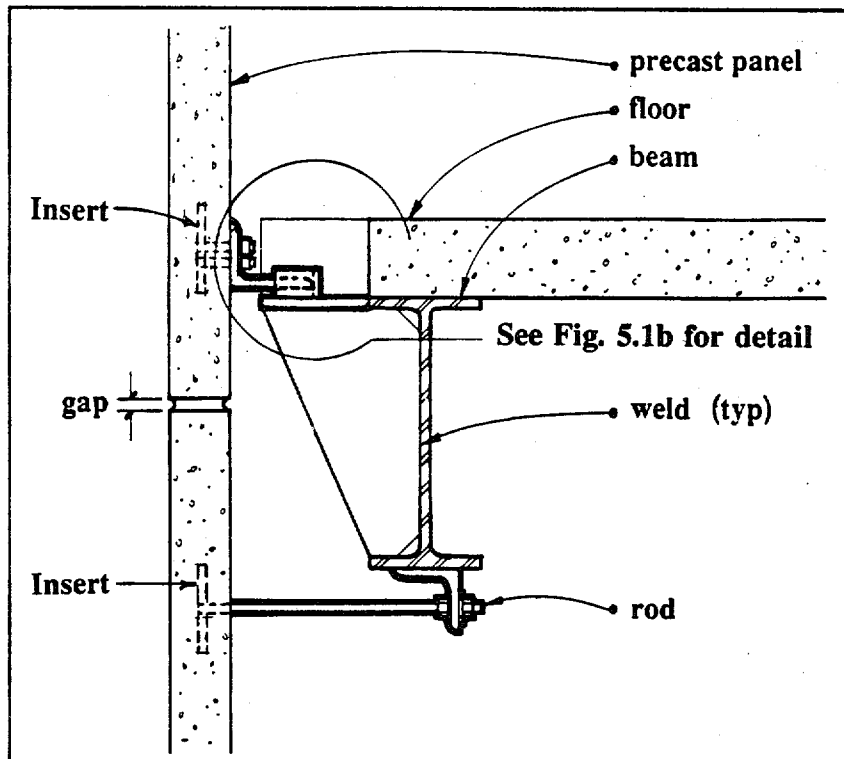
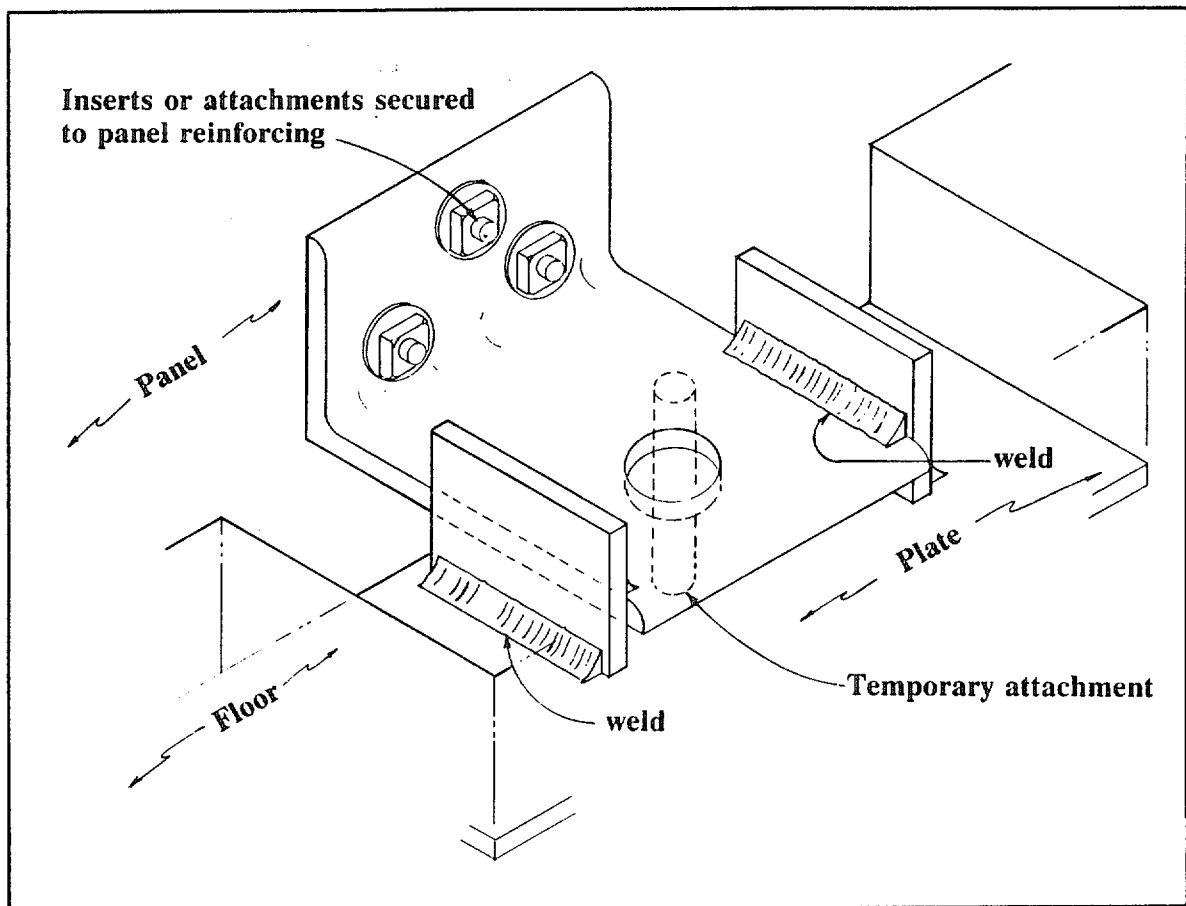


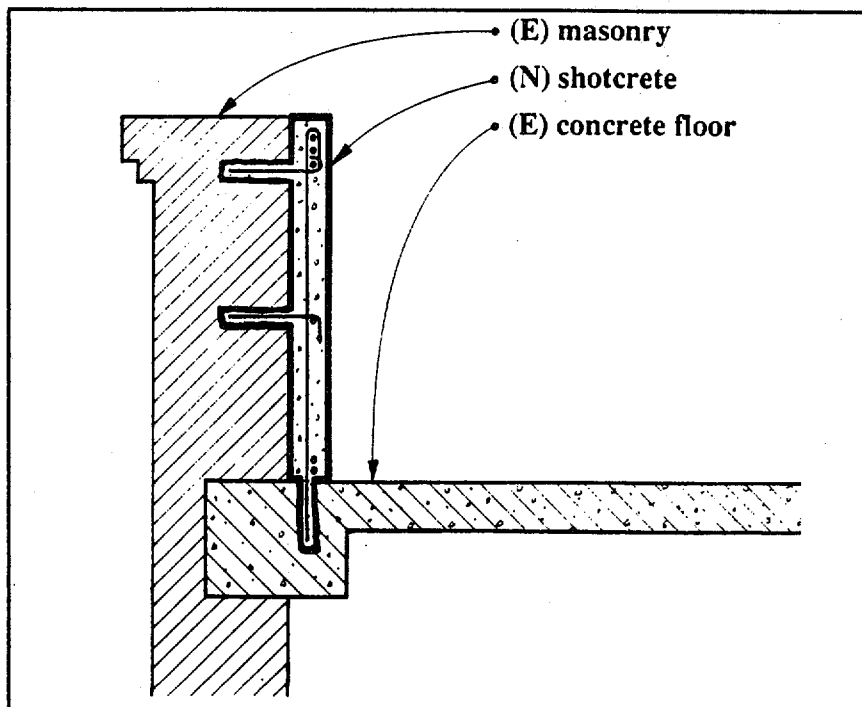
FIGURE 5.1a Flexible connection for precast concrete cladding.



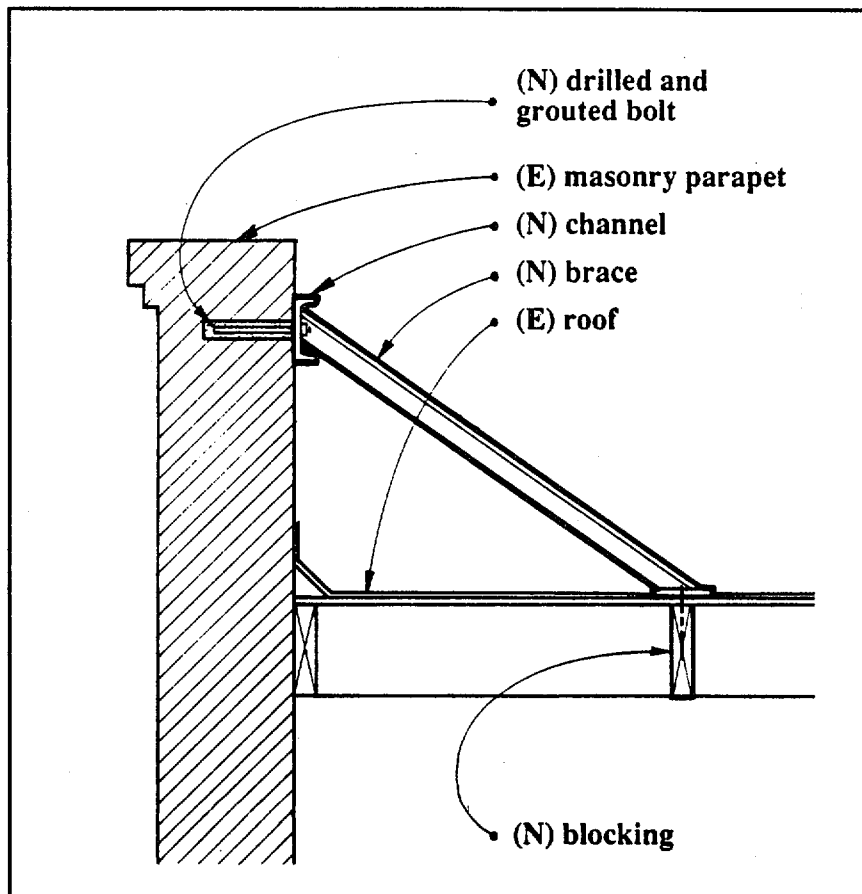
**FIGURE 5.1b** Detail for flexible connection for precast concrete cladding.

## 5.2 APPENDAGES

Cornices, parapets, spandrels, and other architectural appendages that have insufficient anchorage capacity must be retrofitted to prevent damage and, most important, falling debris. Cornice anchorages can be strengthened by removing the cornice material, adding anchorages, and reinstalling the material. A technique that has been used in rehabilitating heavy and ornate cornice work is to remove the cornice and reconstruct it with adequate anchorage and new lighter material such as lightweight concrete or plaster. Parapets can be reduced in height so that the parapet dead load will resist uplift from out-of-plane seismic forces or they can be strengthened with shotcrete (Figure 5.2a) or braced back to roof framing (Figure 5.2b). All elements must be checked for their ability to sustain new forces imposed by the corrective measures.



**FIGURE 5.2a** Strengthening a masonry parapet with a new concrete overlay.



**FIGURE 5.2b** Strengthening a masonry parapet with steel braces.

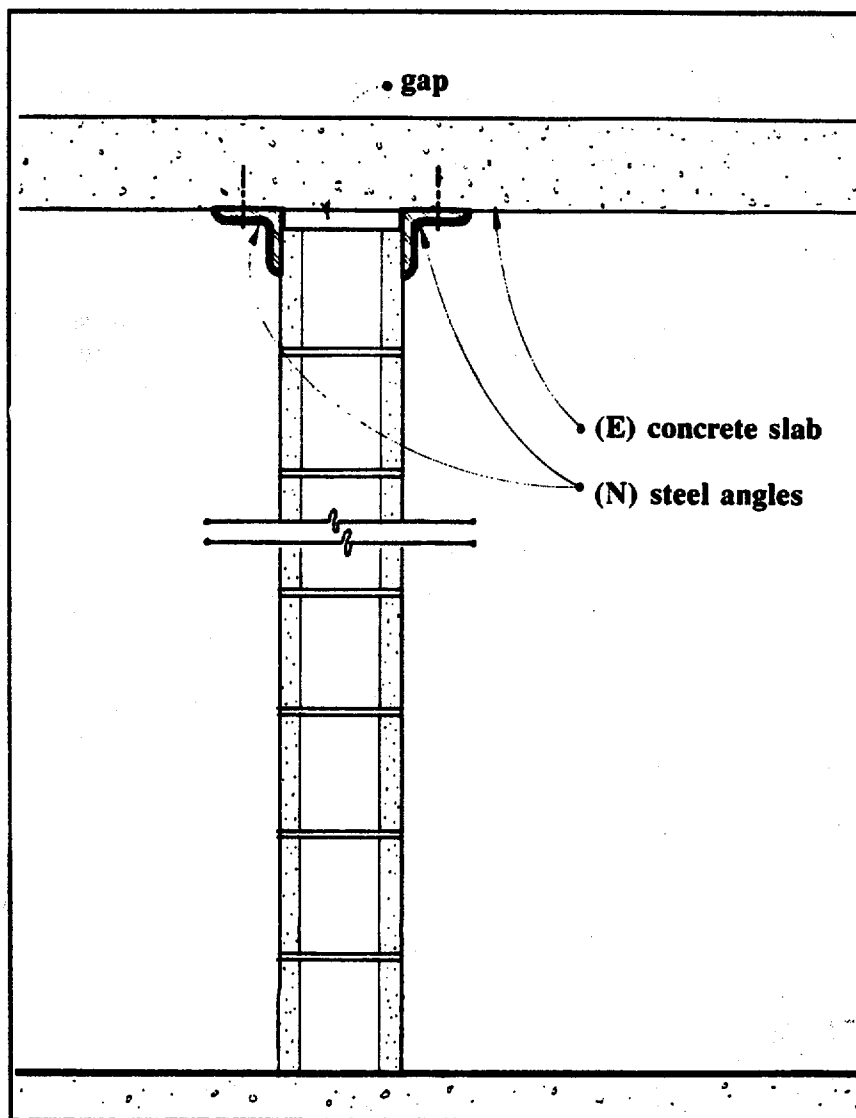
### 5.3 VENEERS

Stone and masonry veneers with inadequate anchorage should be strengthened by adding new anchors. Veneers typically must be removed and replaced for this process. Typical details for approved anchorage of masonry veneers are published by the Brick Institute of America.

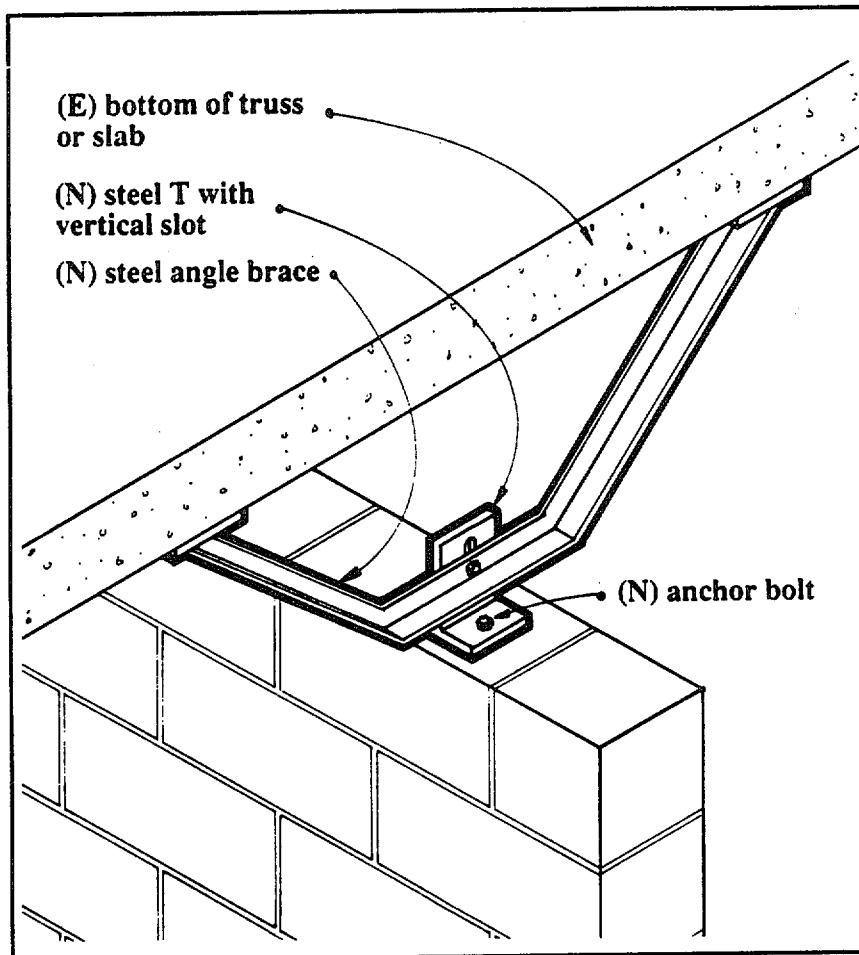
### 5.4 PARTITIONS

Heavy partitions such as those of concrete block may fail from excessive flexural stresses or excessive in-plane shear stress caused by interstory drifts. Such partitions should be retrofitted with connections like those shown in Figure 5.4a that restrain out-of-plane displacement and allow in-plane displacement. Alternatively, unreinforced masonry partitions can be removed and replaced with drywall partitions. Partitions that cross seismic joints should be reconstructed to allow for longitudinal and transverse movement at joints. Plaster or drywall partitions in office buildings generally need lateral support from ceilings or from the floor or roof framing above the partition. Steel channels are sometimes provided at the top of the partitions. The channels are attached to the ceiling or floor framing, they provide lateral support to the partition but allow vertical and longitudinal displacement of the floor or ceiling without imposing any loads to the partition. Partitions that do not extend to the floor or roof framing and are not laterally supported by a braced ceiling should be braced to the framing above (as indicated in Figure 5.4b) at a maximum of 12 foot spacing between braces.

Hollow clay tile partitions occur in many existing buildings as corridor walls or as nonstructural enclosures for elevator shafts or stairwells. Hollow clay tile is a very strong but brittle material and it is very susceptible to shattering into fragments that could be hazardous to building occupants. In many cases it is not possible to isolate these partitions from the lateral displacements of the structural framing and, in those cases, it is advisable to consider either removal of these partitions and replacement with drywall construction or "basketing" of the potential clay tile fragments with wire mesh.



**FIGURE 5.4a** Bracing an interior masonry partition.



**FIGURE 5.4b** Bracing an interior masonry partition.

## 5.5 CEILINGS

Unbraced suspended ceilings can swing independently of the supporting floor and cause damage to the ceilings, particularly at the perimeters. Providing four-way (12-gage wire) diagonals and a compression strut between the ceiling grid and the supporting floor at no more than 12 feet on center and within 6 feet of partition walls will significantly improve the seismic performance of the suspended ceiling. Figure 5.5 shows a typical detail of the four-way diagonals and the compression strut. In addition to the braces, the connections between the main runners and cross runners should be capable of transferring tension loads. Lay-in ceilings are particularly vulnerable to the relative displacement of the supporting grid members. Splices and connections of the T-bar sections that comprise the grid may have to be stiffened or strengthened with new metal clips and self-threading screws.

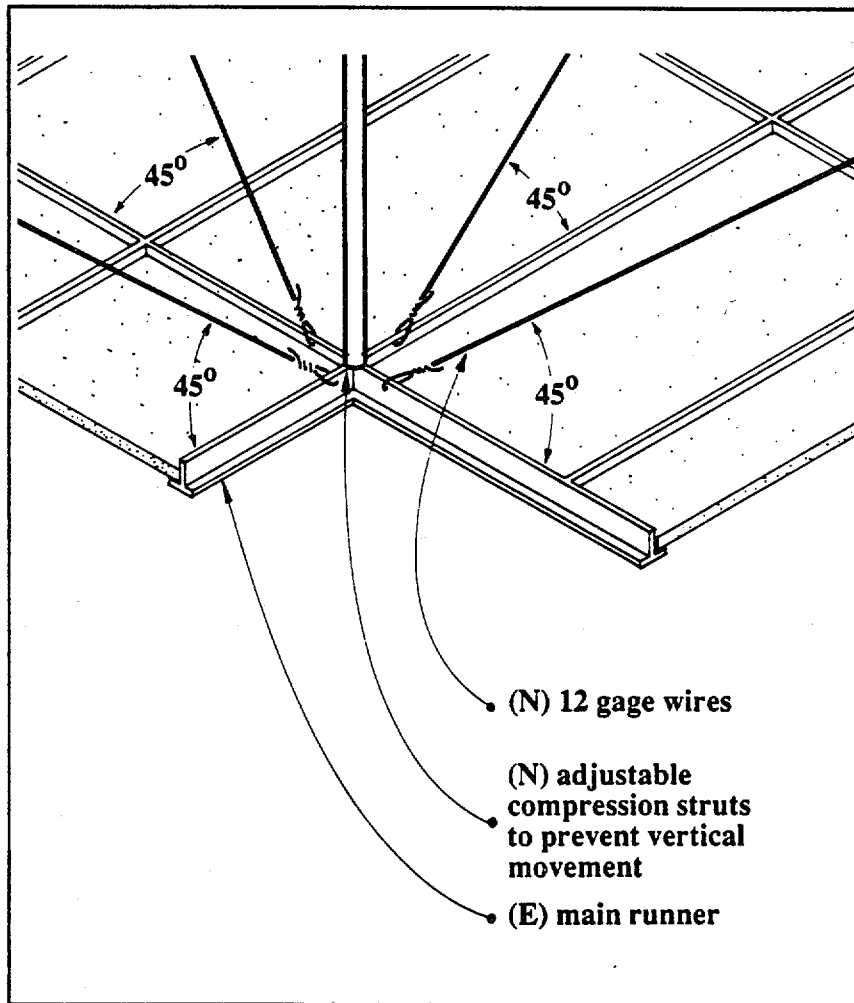


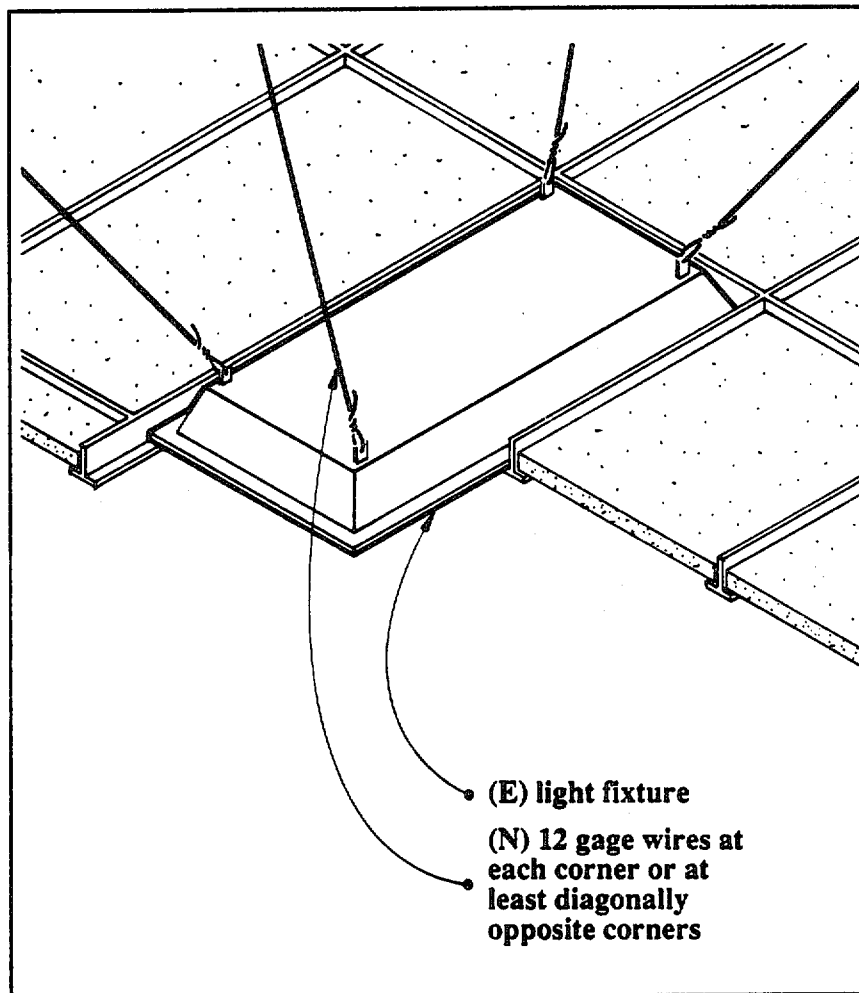
FIGURE 5.5 Lateral bracing of a suspended ceiling.

## 5.6 LIGHTING FIXTURES

Suspended fluorescent fixtures are susceptible to several types of seismic damage. Fixtures that are supported by suspended ceiling grids can lose their vertical support when the suspended ceiling sways and distorts under seismic shaking. Independent wire ties connected directly from each of the fixture corners (or at least diagonally opposite corners) to the structural floor above can be added to prevent the fixture from falling (Figure 5.6).

Pendant-mounted fixtures often are supported by electrical wires. Wire splices can pull apart and allow the fixtures to fall. The fixtures also may swing and impact adjacent objects resulting in breakage and fallen fixtures.

Safety wires can be installed to prevent the fixtures from falling and diagonal wires can prevent them from swaying. Some fixture manufacturers also provide threaded metal conduit to protect the wiring and to support the fixture as well as wire straps or cages that can be added to prevent the fluorescent tubes from falling away from the fixture if they become dislodged.



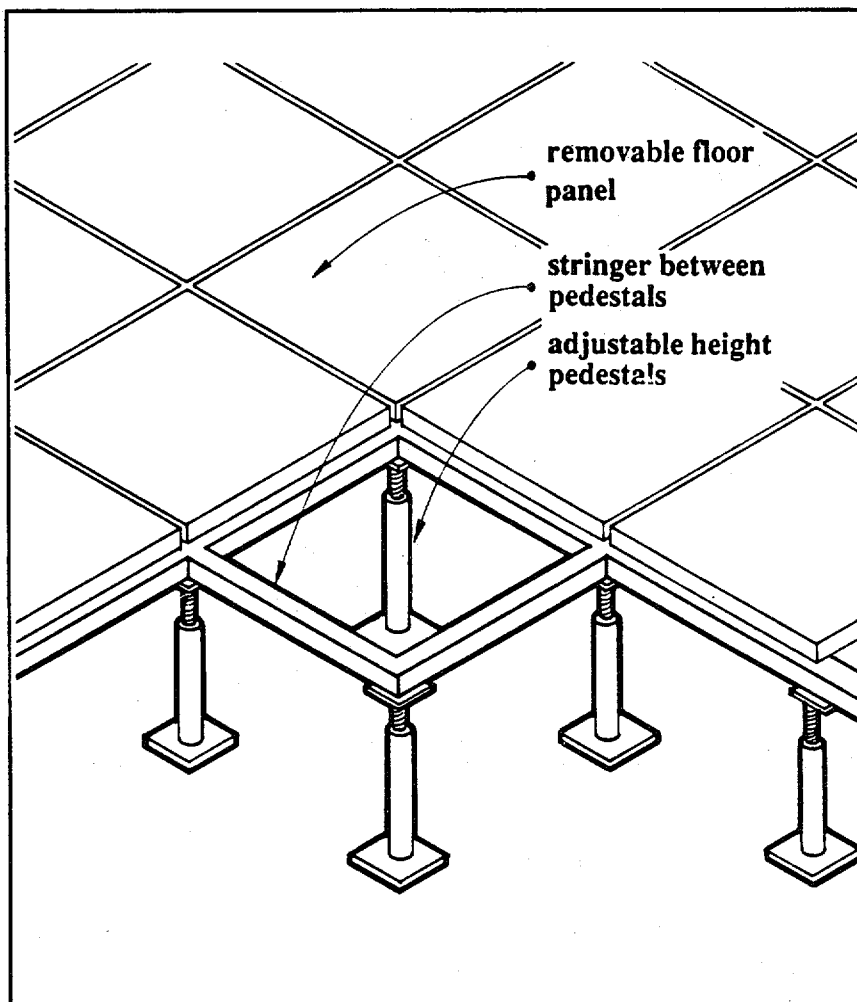
**FIGURE 5.6** Providing safety wires for suspended lighting fixtures.

## **5.7 GLASS DOORS AND WINDOWS**

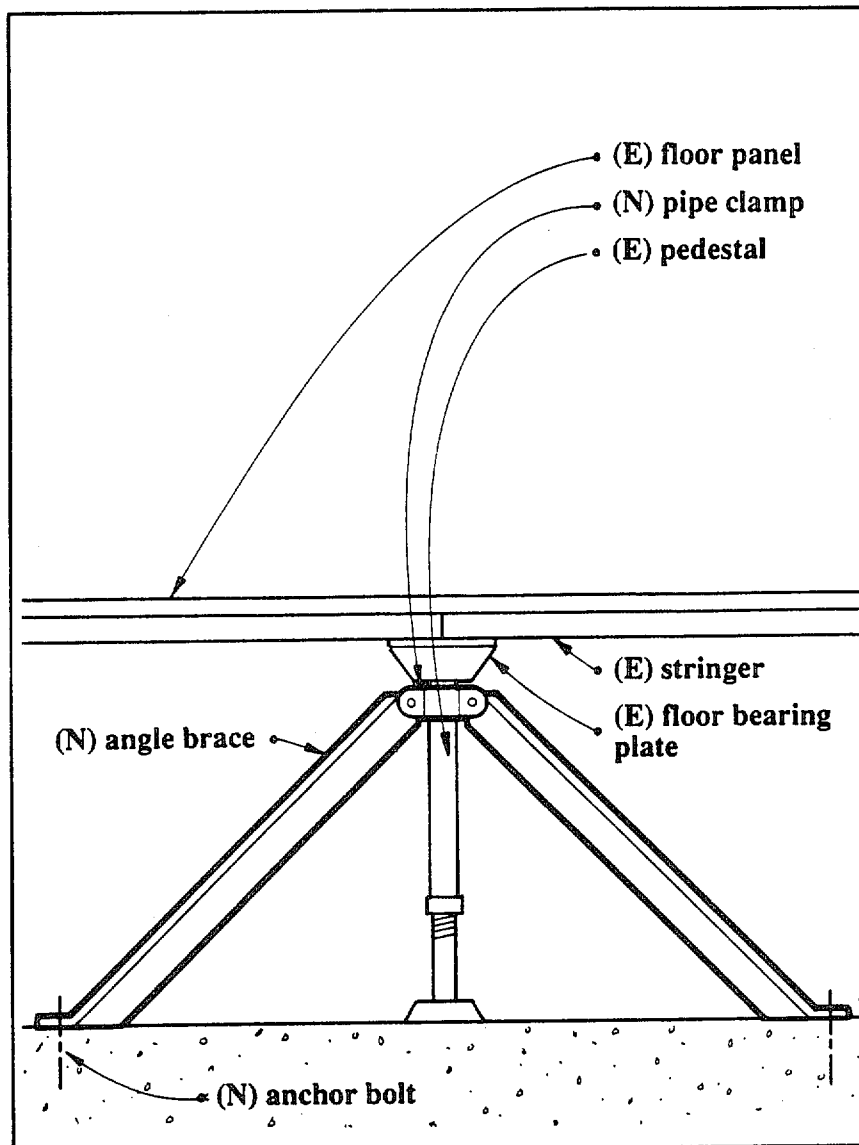
Seismic rehabilitation of glass windows and doors to prevent breakage may be a significant effort. Inadequate edge clearances around the glass to allow the building and, hence, the window frame to rack in an earthquake without bearing on the glass is the principal cause of breakage. Redesign (along with close installation inspection) of the frame and/or glazing to provide sufficient clearance is necessary to prevent seismic breakage. A technique suggested by Reiterman (1985) to reduce life-safety hazards from falling glass is to apply adhesive solar film to the windows. The film will hold together the glass fragments while also reducing heat and glare. The application of solar film to insulating glass may cause heat build-up inside the glass and the possible adverse effects of this build-up need to be considered since damage can result.

## 5.8 RAISED COMPUTER ACCESS FLOORS

Access floors typically are constructed of 2-foot by 2-foot wood, aluminum, or steel panels supported on adjustable column pedestals. The column pedestals frequently are fastened to the subfloors with mastic. Some assemblies have stringers that connect the top of the pedestals (Figure 5.8a) and others have lateral braces. When subjected to lateral loads, access floors typically are very flexible unless they are specifically designed to be rigid. This flexibility may amplify the ground motions such that equipment supported on the floor may experience significantly high displacements and forces. The high displacements also may cause connection failures that could precipitate a significant collapse of the floor. Existing floors can be rehabilitated by securing the pedestals to the subfloor with expansion anchors or by adding diagonal bracing to pedestals in a regular pattern (Figure 5.8b). Rehabilitated floors should be designed and tested to meet both a stiffness and a strength criterion.



**FIGURE 5.8a** Access floor pedestals.



**FIGURE 5.8b Strengthening of access floor pedestals.**